Preface

We are entering an exciting era of B meson physics, with several new high luminosity facilities that are about to start taking data. The measurements will provide information on quark couplings and CP violation. To make full use of the experimental results, it is important to have reliable theoretical calculations of the hadronic decay amplitudes in terms of the fundamental parameters in the standard model Lagrangian. In recent years, many such calculations have been performed using heavy quark effective theory (HQET), which has emerged as an indispensible tool for analyzing the interactions of heavy hadrons. This formalism makes manifest heavy quark spin-flavor symmetry, which is exact in the infinite quark mass limit, and allows one to systematically compute the correction terms for finite quark mass.

This text is designed to introduce the reader to the concepts and methods of HQET, developing them to the stage where explicit calculations are performed. It is not intended to be a review of the field, but rather to serve as an introduction accessible to both theorists and experimentalists. We hope it will be useful not just to those working in the area of heavy quark physics but also to physicists who work in other areas of high energy physics but want a deeper appreciation of HQET methods. We felt that if the book is to serve this role, then it is important that it not be too long. An effort was made to keep the book at the 200-page level and this necessitated some difficult decisions on which subjects were to be covered.

The material presented here is not uniform in its difficulty. Section 1.8 on the operator product expansion, Section 4.6 on renormalons, and Chapter 6 on inclusive B decays are considerably more difficult than the other parts of the book. Although this material is very important, depending on the background of the reader, it may be useful to skip it on first reading. Chapter 3 involves some familiarity with radiative corrections in field theory as studied, for example, in a graduate course that discusses renormalization in quantum electrodynamics. Readers less comfortable with loop corrections can read through the chapter, accepting the results for the one-loop diagrams, without necessarily going through the detailed computations. A section on problems at the end of each chapter is intended to give the reader more experience with the concepts introduced in that chapter. The problems are of varying difficulty and most can be completed in a fairly short period of time. Three exceptions to this are Problem 2 of Chapter 3 and Problems 3 and 7 of Chapter 6, which are considerably more time-consuming.

This book could serve as a text for a one-semester graduate course on heavy quark physics. The background necessary for the book is quantum field theory and some familiarity with the standard model. The latter may be quite modest, since Chapter 1 is devoted to a review of the standard model.

The only references that are given in the text are to lattice QCD results or to experimental data that cannot be readily found by consulting the Particle Data Book (`http://pdg.lbl.gov`). However, at the end of each chapter a guide to some of the literature is given. The emphasis here is on the earlier papers, and even this list is far from complete.

We have benefited from the comments given by a large number of our colleagues who have read draft versions of this book. Particularly noteworthy among them are Martin Gremm, Elizabeth Jenkins, Adam Leibovich, and Zoltan Ligeti, who provided a substantial number of valuable suggestions.

Updates to the book can be found at the URL:

`http://einstein.ucsd.edu/hqbook`.